SCIENCE

VOL. 96 FRIDAY, AUGUST 14, 1942 No. 2485

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SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

Lancaster, Pennsylvania

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary in the Smithsonian Institution Building, Washington, D. C.

A CRITICAL EXAMINATION OF SOME CONCEPTS IN RUBBER CHEMISTRY[1]

By Dr. THOMAS MIDGLEY, JR.

MIDGLEY FOUNDATION, THE OHIO STATE UNIVERSITY

VULCANIZATION

IT is now over one hundred years since Goodyear discovered vulcanization. Broadly speaking, vulcanization is a process whereby a semi-useless vegetal product is converted into the most amazingly versatile raw material the world of industry has ever known. Need I recite your daily contacts with it? For example, when you take a shower bath, your faucet valve is faced with rubber, the curtain is rubberized cloth, the mat that keeps you from slipping is rubber, and the imitation sponge you use is vulcanized rubber in still another form. And when you play, golf balls, tennis balls, footballs and baseballs all depend on vulcanized rubber for liveliness. Notice that I didn't mention tires. They are almost too sacred to talk about these days. And yet after a century, rubber chemists are in less agreement on the nature of the chemistry of vulcanization than Goodyear's neighbors were that he was crazy. Nor has a Hall of Fame jury yet been selected with brains enough to honor Goodyear's memory as it deserves. It is all most astounding; but also is vulcanization.

If one wished to manufacture some rubber article,

[1] The concluding part of the address made by Dr. Midgley on the occasion of the presentation to him of the Willard Gibbs Medal of the Chicago Section of the American Chemical Society at Chicago on May 27. The presentation of the medal was made by Professor Harry N. Holmes, national president of the society.

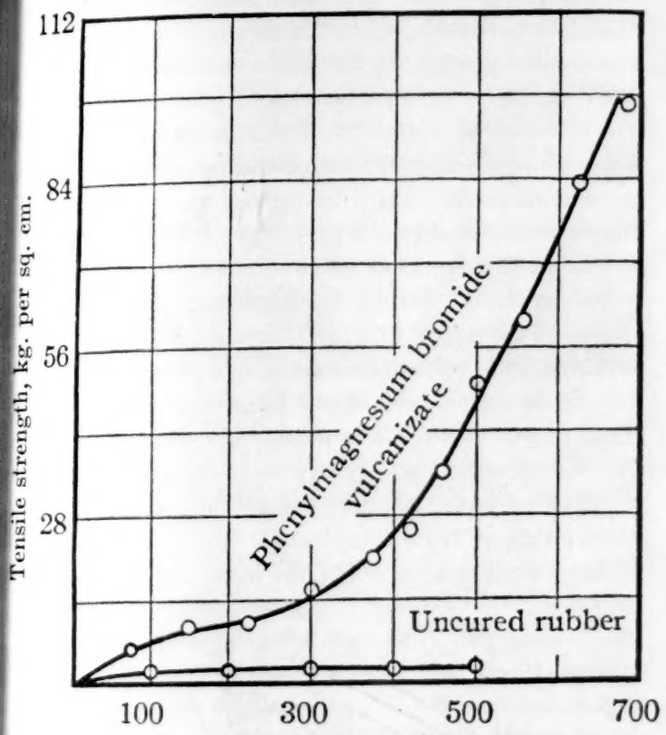
the first thing is to get a priority order; after that, the crude rubber may be obtained. The crude rubber is broken down on a mill to make it plastic, sulfur and other things are added, and the rubber is shaped to the desired form and held there for some time while being heated; after that the article is finished. Comparison of the crude rubber and the finished article will show that many physical properties are remarkably alike qualitatively, although enhanced quantitatively in the vulcanizate. Naturally, this suggests that vulcanization is reversed breakdown; therefore, if breakdown is the result of molecular ruptures, it logically follows that vulcanization must be molecular building up by polymerization or condensation. This indeed is an easy conception to visualize. It gives an explanation of the part played by sulfur—simply that the sulfur atom connects two rubber molecules by joining to each of them by primary valences. The simplicity of this broad concept has won many converts, too many, for it has one grave error. There is not one single piece of sound evidence that it is true and many that it is not. In the first place, vulcanization is not breakdown in reverse, except in a very superficial way. Incipient and then progressive vulcanizates do not show the regular steps of increasing viscosity and decreasing solubility that would be expected; nor can a vulcanizate be obtained that gives quantitative properties corresponding to those of unbroken-down rubber. At first there is a slight rise in viscosity during vulcanization and a slight decrease in solubility, then a sudden conversion to a gel type rubber. During the early stages of this gel formation the gel can be peptized by various agents.[2] Who ever heard of peptizing primary valences?

Consider both breakdown and vulcanization from a different point of view. Instead of assuming that unbroken-down rubber is elastic with fair tensile strength because its molecules are long and that broken-down rubber is plastic because its molecules are short, imagine that the difference in plastic properties of unbroken and broken-down rubber is caused by a difference in the ease with which the molecules slip past one another under stress. True, this difference may be the result of different lengths of molecules or it may be that in broken-down rubber a few small molecules act as lubricants for the larger ones just as a small amount of lubricating oil in unbroken-down rubber will give a plasticizing effect. This concept does not require the rebuilding of large molecules out of small ones to account for the change that is called "vulcanization." Any procedure which results in reduced slipping will accomplish a change of this sort; witness the loading effect of carbon black or zinc oxide. But the reduction of slipping is not all there is to vulcanization. Were it all, then vulcanized rubber would disperse instead of merely swell in suitable solvents. Therefore we must assume the creation of intermolecular attractions of some sort during vulcanization. This, of course, can be accomplished by sulfur bridges between molecules. If this were the only possibility, the slipping concept would merely have been a mental detour which returned to the original starting point. But sulfur bridges are by no means the only way to stop slipping. We also have the possibility of creating groups on the molecule which will cause association. Call these polar groups or secondary valences or what you will, but in any case they differ distinctly from primary valences. The question now resolves itself into differentiating between these two concepts—namely, attraction by primary valences and attraction by association forces. The following observations are pertinent. If vulcanization is stopped at a point just beyond gel formation—that is, where the vulcanizate will swell but no longer disperse in rubber solvents—then this vulcanizate can be dispersed by peptization.[3] It is difficult to see how this could be so if this gel were held together by primary valences; on the other hand, a gel held together by association forces would be expected to behave in such a manner. Again, as the amount of combined sulfur increases, a maximum point of vulcanization properties is reached after which most of these properties decrease until, at about half saturation, the vulcanizate has decreased in physical properties corresponding almost to the condition of broken-down rubber. It is difficult to see how this can be explained on the basis of primary valence formation; whereas if the forces of association are considered to be due to the formation of some kind of polar groups, the phenomenon becomes easily explainable on the basis that, as long as the polar groups of a given molecule are far enough apart, strong external forces, capable of attracting other molecules, will be in existence. But when the number of such groups are increased and they are crowded closer together, their respective forces will be satisfied by internal attraction leaving only a small portion for attracting other molecules. This explanation admittedly is hypothetical, but it serves to demonstrate that a rational explanation of the phenomenon of overvulcanization can be based on the concept of association forces, whereas no similar explanation is forthcoming based on the primary valency concept. Even the simple observation that the slight swelling by solvents of well-vulcanized rubber greatly reduces its tensile strength also favors the association concept. For if the mass were held together by primary valences, there would seem to be no more reason for

[2] Williams, *Ind. Eng. Chem.*, 26: 1190, 1934.

[3] *Ibid.*

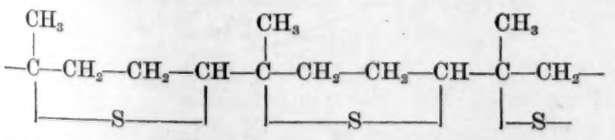
a loss of strength than occurs in a sponge when it is filled with water, while if it were held together by association forces, the adsorption of solvent would increase the distance between molecules and thus reduce the strength of the forces holding them together.



STRESS-STRAIN CURVE

FIG. 1

Several years ago we attempted to establish the existence of primary valence linkages between molecules by destructively distilling well-vulcanized rubber and examining the products in the hope of finding one which could be related to such a linkage. The resulting products differed in no significant detail from those obtained from the destructive distillation of crude rubber. We next extended this work to the destructive distillation of ebonite $(C_5H_8S)_n$, without obtaining any compound suggestive of intermolecular linkage.[4] We did obtain a group of substituted thiophenes, representing only a small part of the whole, which we interpreted[5] as demonstrating a linkage of sulfur to the rubber molecule:



While such negative evidence can not be considered as disproving the possible existence of primary valence linkages between molecules, it does add to the total weight of evidence against their existence.

[4] Midgley, Henne and Shepard, *Jour. Am. Chem. Soc.*, 54: 2953, 1932.

[5] *Ibid.*, 56: 1326, 1934.

In contradistinction to the negative results obtained in our search for evidence to substantiate the primary valency concept, we were able to obtain positive evidence that association forces could be used exclusively for vulcanization. We discovered that the addition of Grignard reagents to rubber solutions would cause gelling. We extended this discovery to the vulcanization of a test sample of broken-down rubber.[6] The resulting stress-strain curve is shown in Fig. 1. This is a typical curve for a vulcanizate. The tensile strength is too great for a mere loading effect, and it is difficult to see how a small amount of methyl magnesium bromide could act as a loading agent anyway; nor is the tensile strength so very bad when it is considered that no loading agent was present. There can be no question that this result is true vulcanization. Grignard reagents do not produce intermolecular linkages; also the vulcanizate could be reverted to its original broken-down condition by counteracting the Grignard with alcohol. The recovered product could be revulcanized with Grignard and recovered again as many times as desired, a further demonstration that intermolecular primary valences were not generated in the vulcanization.

In view of the preponderance of evidence in favor of the association concept of vulcanization and the complete lack of any basis for the primary valence concepts, it is surprising that rubber chemists continue to think in terms of primary valence as an explanation of the vulcanization reaction.

RETRACTION

The retraction of rubber—that is, the property which causes rubber to return to its original shape and size with force after being stretched—is the outstanding characteristic that distinguishes it from chewing gum, beeswax and tar, and makes it into the useful material it is. The study of this property really falls in the field of physics rather than chemistry, but its importance justifies its inclusion in any discussion of rubber or rubber chemistry. Indeed, this property is so important that any material which possesses it can be called a rubber, no matter what its chemical constitution.[7]

The early students of this property took the viewpoint that rubber was analogous to gelatin in some way, that it was some sort of two-phase system,[8] that it was a colloidal suspension,[9] that it was corpuscular in structure,[10] that its molecules were gathered together in miscelles,[11] etc. None of these conceptions

[6] *Ibid.*, 56: 1156, 1934.

[7] Midgley, in Davis and Blake's "Chemistry and Technology of Rubber," A. C. S. Monograph 74, p. 679, 1937.

[8] Freundlich and Hauser, *Kolloid-Z.*, Spec. No. 36, 15, 1925.

[9] Pummerer, Nielson and Gündel, *Ber.*, 61: 1583, 1928.

[10] Freundlich and Hauser, *loc. cit.*

ever yielded constructive results or advanced rubber technology.

Some twenty-odd years ago, after Staudinger announced the long-chain structural formula, opinion began taking shape that the extension and retraction of rubber were simply an integration of the behavior of the component molecules.[12] In other words, it was assumed that the rubber molecule itself is subject to extension and exhibits forceful retraction thereafter. This concept has steadily gained ground. It is true that no direct evidence exists to confirm this concept, and by its very nature perhaps there never will be; on the other hand, no contradictory evidence exists, which very well could if this concept were in great error. Therefore, until some such evidence is obtained or a concept is developed which fits the facts more accurately, this theory should be accepted as the nearest available approach to the truth.

Under this concept a generalized theory of molecular behavior has been developed. For example, refer to Staudinger's long-chain formula above. It is obvious that this is not a true space configuration since the tetrahedral characteristics of carbon atoms are disregarded. Imagine such a space model and take into account that parts of this molecule can rotate about any single bond. Now fold the molecule back on itself many times about single bonds and a much more compact model is obtained than would appear from looking at the long-chain formula. This is a good picture of how a rubber molecule may retract, but it gives no insight into why it does so. Long paraffin molecules, such as hydrogenated rubber, could do the same thing as far as structure goes, but they do not. Rubber molecules do. Why?

Two explanations have been offered; one is by Shecklock[13] with later variations by others, based on thermal and thermodynamic considerations, and one is by Mack,[14] who makes use of van der Waals forces, applied to scale models. I am incompetent to differentiate critically between these two. Each of them fits certain observed data better than the other, but Mack's concept appeals more strongly to me, as it is based more closely in the fields of rubber chemistry with which I am familiar, and it predicts quite well the behavior of rubberlike and related substances of known composition, structure and isomerism. Its extension might be useful in predicting new molecular forms which could lead to better and less expensive synthetic rubbers than we now have.

As just stated before, I am not qualified to criticize either of the above theories, but I do feel qualified to criticize both rubber chemistry and chemists for not having mastered either of them more thoroughly. That they are difficult to master is no excuse, for the rubber chemist who expects to serve humanity well must be prepared to master many things more difficult than either of these theories.

In closing I should like to make myself clear on one point. I have not hesitated to criticize, severely, those concepts which are in disagreement with the results that I and my colleagues have obtained. I have done this in the full knowledge that I can be just as wrong as any one else, and I shall feel grateful to any one who proves that I have been, for then I shall profit by such proof in increasing my own understanding of these problems. Likewise I shall feel pleased if our results are confirmed, for then I shall have the satisfaction of feeling that I have aided in advancing rubber chemistry. I can be disappointed in only one way, to have our results ignored.

[11] Meyer and Mark, *Ber.*, 61: 1939, 1928.
[12] Astbury, *Ann. Repts. Chem. Soc.*, 1931, 322.
[13] Shecklock, *Trans. Inst. Rubber Ind.*, 8: 568, 580, 1933; 9: 94, 1933.
[14] Mack, *Jour. Am. Chem. Soc.*, 56: 2757, 1934.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE TWENTY-SIXTH ANNUAL MEETING OF THE PACIFIC DIVISION. II

Edited by Professor J. MURRAY LUCK
SECRETARY

AMERICAN SOCIETY OF PLANT PHYSIOLOGISTS, WESTERN SECTION

(Report by D. I. Arnon)

The annual meeting of the Western Section of the American Society of Plant Physiologists was held at Salt Lake City, Utah, from June 17 to June 19.

The effect of war conditions was reflected in a number of last-minute cancellations of papers by prospective participants, but the cooperation of societies in arranging joint sessions for topics and papers of mutual interest contributed to the success of the meeting by favorably influencing both program and attendance. The program consisted of a symposium on "Organic Matter in Relation to Plant Growth," sponsored jointly with the Western Society of Soil Science and the Western Section of the American Society for Horticultural Science; a symposium on "Present Concepts of Water Relations of Plants,"

sponsored jointly with the Pacific Division of the Botanical Society of America and the Horticulturists; and three sessions of submitted papers, one session with the Botanists and another with the Horticulturists.

The symposium on organic matter in which papers were presented by J. Bonner, L. T. Kardos and jointly by J. E. Greaves, K. R. Stevens and L. W. Jones assessed some of the present concepts on the direct and indirect role of specific organic substances on the growth of intact plants under natural conditions in soil.

The symposium on water relations, which attracted the interest of many, covered in a series of well-prepared papers the following aspects: the forces governing absorption and movement of water in plants, by A. S. Crafts; the structure and function of water-conducting tissues, by H. E. Hayward; the relation of soil moisture at various levels to plant growth, by L. A. Richards; and problems of water deficiency with special reference to grasses, by D. F. McAlister.

The Thursday morning session for submitted papers included the presentation of data obtained under highly controlled conditions on root respiration and certain phases of sulfur metabolism in plants by M. D. Thomas, R. H. Hendricks and G. R. Hill. A negative correlation between CO_2 evolution by roots of Vinifera and Labrusca grapes and the respective susceptibility to chlorosis was reported by F. B. Wann. H. E. Hayward, W. M. Blair and P. E. Skaling found by means of a special device that the most active zone of water absorption in corn and citrus roots is that of the region of differentiation. H. T. Northen discussed the relation of cellular activities to protein behavior with special reference to reactions involving protein dissociation, and J. Bonner presented observations on the distribution and transport of riboflavin and pantothenic acid in plants.

Other papers included an interesting study of chlorofucine and fucoxanthine, green and yellow pigments of diatoms and brown algae, by H. H. Strain and W. M. Manning. The continuous application that radioactive isotopes find in physiological research was reflected in a paper by O. Biddulph on the movement of radiophosphorus and in another by T. C. Broyer and D. R. Hoagland on the relation between permeability and accumulation. Three papers dealt with micronutrient deficiencies: H. S. Reed discussed the effect of nutrition on vacuolar components, E. Archibald and F. B. Wann reported on the zinc content of deficient and normal leaves, and D. I. Arnon reviewed the present status of the indispensability of molybdenum for higher plants. C. H. Davis presented evidence on the direct relation between reduced moisture content and the decreasing rate of growth, and W. O. Williams reported on the effects of temperature on the composition of tracheal sap in some woody plants.

A most interesting trip through the greenhouses and laboratories of the American Smelting and Refining Company, conducted by Drs. G. R. Hill and M. D. Thomas, was enjoyed by the group on Friday afternoon.

The officers for the coming year, as announced at the annual dinner are: *Chairman,* E. T. Bartholomew; *Vice-Chairman,* F. J. Veihmeyer; *Secretary,* D. I. Arnon.

Association of Pacific Coast Geographers

(Report by Willis H. Miller)

The first day of the association meeting was devoted to the geography of Utah, with special emphasis on the unique farm villages which characterize the Mormon commonwealth. In a paper on "Utah House Types" Dr. J. E. Spencer, of the University of California at Los Angeles, traced the history of Utah houses from the earliest ill-adapted "Hollywood" stucco bungalow. Dr. J. A. Geddes, of the Utah State Agricultural College, called attention to the large areal extent and the widely scattered houses typical of many Mormon farm villages. To this feature he largely attributed the low proportion of homes having piped water, gas, electricity and sewage connections. As a solution, Dr. Geddes recommended the development of long, narrow farmsteads, each having relatively short frontage on the main village street.

During the afternoon a spirited symposium on "Utah Mormon Village Communities" was held under the leadership of Dr. George H. Hansen, of Brigham Young University. A qualified panel of experts thumped and probed the physical, economic and social bodies of Utah villages. It was agreed that, although these villages have relatively declined, a combination of community pride and good planning could again make them attractive, efficient places in which to live and make a living.

At the morning session on the second day, D. W. Thorne, of the Utah State Agricultural College, and D. A. Anderson, of Brigham Young University, discussed "Irrigation and Permanent Agriculture." An analysis of ancient irrigation projects and studies of Western irrigated lands led them to conclude that irrigated agriculture was as permanent as any other type. Dr. L. O. Quam, of the University of Colorado, illustrated his timely paper on "The Use of Maps in Propaganda" with a collection of recent German maps.

Papers presented during the afternoon included an illustrated talk on "Erosion Lessons to be Learned

from Mexico," by W. A. Rockie, of the Soil Conservation Service. Mr. Rockie stated that erosion is so wide-spread that he believes Mexico will be hard pressed to produce enough food to support its population within fifty years. In his paper, "Geopolitics—Some Implications and Applications," Dr. Willis H. Miller, of the California State Planning Board, stressed the value of geopolitics as a device for determining policy, recommended the establishment of a Federal Geopolitical Office, and outlined several examples of geopolitics as applied to current and future problems of the United States.

Botanical Society of America, Pacific Section

(Reported by Bassett Maguire)

The program of the Botanical Society consisted of one symposium and four half-day sessions for the presentation of submitted papers.

In the Wednesday morning session three interesting papers dealt with some physiological and genetical problems of the sugar beet; two further papers treated the distribution of members of the Saprolegniaceae in Southern California and Desmid records for Utah.

On Wednesday afternoon a most interesting joint symposium was held with the Physiological Society of America and the American Society for Horticultural Science on the "Present Concepts of Water Relations of Plants." A. S. Crafts, H. E. Heyward, L. A. Richards and D. F. McAlister presented papers.

The Thursday morning session, held jointly with the Ecological Society of America, consisted of a presentation of papers, primarily ecological in nature. A series of papers treating various problems of range ecology and management elicited much interested comment. Others dealt with soil drought resistance in grasses, and production and maintenance of zooplankton in coastal waters of southern California.

A joint session for the presentation of papers of primarily taxonomic nature was held on Friday morning. The paper given by C. L. Hitchcock, dealing with the origin of the Western species of *Draba,* excited considerable interest, as did likewise two following papers presenting a taxonomic-ecological relationship of the genus *Zigadenus,* and a discussion of the Post-pleistocene vegetation and climate of the Pacific Northwest.

At the annual business meeting held on Wednesday morning the following officers were elected: *President,* Henry P. Hansen; *Council Member,* W. R. Hatch.

California Academy of Sciences

(Report by R. C. Miller)

The program of the California Academy of Sciences took the form of a progress report of the Committee on Natural Illumination authorized at the Pasadena meeting a year ago. At a session on Thursday morning, R. C. Miller gave a general report on the organization and work of the committee, and presented some results of continuous recordings of daylight in San Francisco over a period of nine months. C. L. Utterback reported on the visibility of near and more distant objects, and of different colors, in morning and evening twilight of carefully measured intensities. The session concluded with a round table discussion of the applications of illumination studies in various fields, with emphasis on the possibilities of their use in meteorological forecasting.

Ecological Society of America, Western Section

(Report by A. M. Woodbury)

The Ecological Society of America, Western Section, held its meetings on June 17 and 18. The excursions scheduled for June 19 and 20 had to be cancelled because of transportation problems related to war activity. On Wednesday morning, June 17, a symposium dealing with "Salinity as an Ecological Factor" was held jointly with the Western Society of Naturalists. Four papers were presented: W. D. Billings dealt with plants in the Lahontan Basin; Seville Flowers, with plants in the Bonneville Basin; Angus M. Woodbury, with animals in the Great Basin; and Walter P. Cottam, with plant types after a century of human occupancy.

The Biologists' dinner on Wednesday evening was attended by many ecologists. On Thursday morning, a joint session with the Botanical Society of America, Pacific Division, was held, at which seven papers were presented by S. S. Hutchings, George Stewart, L. A. Stoddart and A. D. Smith, A. W. Sampson, D. F. McAllister, O. S. Walsh and M. W. Johnson.

The Oceanographic Society of the Pacific

(Report by C. L. Utterback)

The program of the society consisted of a symposium on the "Resources of the Sea for Wartime Economy," and of an afternoon session of contributed papers.

"The Latent Marine Fisheries Resources of the Pacific," from Alaska to the coast of Mexico, were discussed by Dr. R. S. Croker, of the California State Fisheries Laboratory, and Dr. W. M. Chapman, of the Washington Shellfish Laboratories. An interesting analysis of the abundance and possible utilization was made of the many resources which are not now used commercially. This analysis included the results of the investigations of the various fish commissions, as well as a discussion of the problems pertaining to the canning and marketing of many of the less familiar food fish. The discussion of the Marine Plant Resources was similar in nature to that of the

Marine Fisheries Resources. Problems relating to the abundance of various marine plants and the immediate utilization of considerable amounts of their products were included. This discussion was led by Drs. G. B. Rigg and Trevor Kincaid, of the University of Washington, and Dr. J. F. Wohnus, of the Scripps Institution of Oceanography.

An interesting paper presented by R. P. Dempster and R. C. Miller included the effect of the character and abundance of plankton on the penetration of solar light into sea water.

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

(Report by Charles C. Johnson)

The meeting of the Society for Experimental Biology and Medicine was held on Friday, June 19, at 1:30 P.M. Ten papers were read by the authors and four were read by title, as the authors were unable to be present.

J. Wolk and W. W. Smith, of the Department of Bacteriology of the University of Southern California, reported that 95 to 98 per cent. of samples of sugar obtained on the retail market would pass National Canners' tests and hence were suitable for home canning purposes.

Morphine used as a sedative in labor may either depress or stimulate uterine motility or have no effect whatever, apparently depending largely on the type and degree of uterine motility existing at the time of the administration of morphine. Dr. Con Fenning, of the department of pharmacology and physiology of the University of Utah, drew these conclusions after studies of uterine motility on 200 patients, using a recently perfected apparatus for recording uterine movement in pregnant women.

Dr. H. M. Schamp and Dr. H. M. Leicester, of the College of Physicians and Surgeons, Dental School of San Francisco, presented a new method for clearing teeth and bone by immersion in liquefied phenol for twenty-four hours. They then used this method to study caries in the teeth of rats to establish a caries index.

Using mercury-indigo-disulfonate, Dr. J. E. Davis was able to bring about either complete disappearance or regression of breast cancer in mice.

Clarence R. Mott, of the department of pharmacology and physiology of the University of Utah, reported a direct correlation between the increased growth and the basal metabolism in ovariectomized rats when proper selection of animals was made with relation to age and time elapsing between ovariectomy and determination of basal metabolism. He found that there was a statistically significant increase in basal metabolism in the ovariectomized rats when the operation was performed at 26 days of age and the basal metabolic rates compared with controls at the ages of 40 to 90 days.

WESTERN SOCIETY OF SOIL SCIENCE

(Report by W. P. Martin)

The meetings of the Western Society of Soil Science were featured by extensive field trips, cordiality of association and a representation from all the eleven western states. Attendance ranged from 40 to 80 soil scientists who listened to and discussed 26 papers on current research during four half-day sessions. In addition, three papers were presented during a symposium on "Organic Matter in Relation to Plant Growth," under the chairmanship of W. P. Kelley, in which the soil scientists collaborated with the plant physiologists and the horticulturists.

Papers ranged from a description of some of the results obtained on the excellent sand culture installation of the American Smelting and Refining Company by M. D. Thomas and R. H. Hendricks to the effect of denitrifying bacteria on soil structure by V. P. Sokoloff. The papers presented on Monday morning dealt chiefly with the influence of environmental factors on plant growth. Acidulated materials, phosphatic fertilizers, sulfur and alkaline salts were included in these discussions.

On Monday afternoon, the scientists examined soil profiles peculiar to the Salt Lake Valley under direction of D. S. Jennings. In the evening, a picnic supper was provided for 65 by the Utah State Agricultural Experiment Station in Logan Canyon; Professor D. R. Hoagland and O. C. Magistad contributed remarks on the place of the soil scientist in the war effort.

On Tuesday morning, papers ranged from a mathematical description of the precipitation data for Utah as related to erosion due to the influence of carbon dioxide pressure on the measurement of pH values. The effect of surface mulches on water intake, the influence of moisture tension on moisture retention, water-application efficiencies in irrigation and methods used for the reclamation of an alkali soil in Wyoming were discussed during this session.

On Tuesday afternoon the group were shown over the Davis County Water Shed Conservation Project of the Intermountain Range and Forest Experiment Station by George Stewart. How destructive floods had been effectively controlled by water-shed conservation practices was strikingly demonstrated on this trip.

On Wednesday afternoon, the eight papers presented dealt largely with the influence of environmental factors on soil properties. The influences of

irrigation, long-continued tillage of orchard soils, organic materials and soil microorganisms were considered. In addition, enzymatic *vs.* microbial concepts of urea hydrolysis, the maintenance of nitrogen in dry farm soils and the persistence of algae in old adobes were topics presented.

At the banquet on Wednesday evening at which were present fifty-one members and guests, President F. S. Harris, of Brigham Young University, described some interesting and peculiar agricultural problems of Iran.

Officers of the society elected for the coming year were as follows: *President,* T. L. Martin, Brigham Young University; *Vice-President,* O. C. Magistad, U. S. Regional Salinity Laboratory; *Secretary-Treasurer,* W. P. Martin, University of Arizona.

OBITUARY

RAYMOND L. DITMARS

As a keen student of human nature has reminded us, "Contemporaries appreciate the man rather than the merit, but posterity will regard the merit rather than the man." Most creative thinkers are content to have it this way, for they realize that they labor for future generations rather than for their own. The life and works of Dr. Ditmars will illustrate the truth of the observation. Quietly and persistently he toiled in his chosen field. To many biologists he was but little known; to others he was the modest curator of reptiles in the New York Zoological Park. But it may be safely predicted that future historians of American zoology will recognize in him an important contributor to the science.

Scientists too generally fail to appreciate that research is promoted not only by the efforts of skilled investigators but also by the labors of those who undertake to develop the students of the future. Zoologists particularly are prone to decry attempts to popularize the results of their studies. This is unfortunate, for most teachers will testify to the great value of natural histories and manuals in stimulating in the youthful mind an interest in the natural sciences. It is to this field that Dr. Ditmars has contributed effectively and permanently. He has successfully popularized, in the best sense of the term, the study of reptiles, and the results are already appearing in an augmented group of specialists in the habits, distribution and relationships of an important, difficult, neglected and much maligned group of animals.

Thus, while it will be the future Copes, Boulengers and Stejnegers who will really give to this man full credit, we who are privileged to have known him may feel proud to have been associated with one who is destined to be considered a good teacher. He would desire no other epitaph.

Dr. Ditmars died on May 12. The events of his life are given in biographical directories. "American Men of Science" prints the following:

Ditmars, R(aymond) L(ee), Zoological Park, New York, N. Y. *Natural history.* Newark, N. J., June 20, 76. Pub. and private schs. Asst. curator entom, Am. Museum Nat. Hist, 91–97; stenographer, 97–99; reporter, 'N. Y. Times,' 99–00; *curator reptiles, N. Y. Zool. Park, 00–, mammals, 27–* Soc. Ichthyol. and Herp; N. Y. Zool. Soc; N. Y. Entom. Soc; Linnaean Soc. N. Y. Herpetology; mammalogy; educational motion pictures.

ALEXANDER G. RUTHVEN
UNIVERSITY OF MICHIGAN

HENRY FRANCIS NACHTRIEB

HENRY FRANCIS NACHTRIEB, professor emeritus of animal biology at the University of Minnesota, died at his home in Berkeley, California, on July 17 in his eighty-sixth year. He is survived by his wife and daughter. Born near Galion, Ohio, in 1857, Professor Nachtrieb began his higher education at German Wallace College at Berea, Ohio. From there he came to the University of Minnesota and received his B.S. degree in 1882. Graduate work at the Johns Hopkins University from 1883 to 1885 completed his professional training. Returning to the University of Minnesota in 1885 as an assistant, he became assistant professor the following year and department head in 1887, which position he held until his retirement in 1925.

During his long service to the university he was untiring in his efforts to build up the work in zoology. When Governor John S. Pillsbury was considering the gift of a building to the university in 1889, Professor Nachtrieb was influential in having the building devoted to the natural sciences. As the work grew, and additional space became imperative, he was again influential in securing a legislative appropriation for a new building to be devoted exclusively to zoology. This fine modern laboratory was built in 1915, according to plans largely developed by him.

During the years of the Geological and Natural History Survey of Minnesota, Professor Nachtrieb was active in directing this work as state zoologist. At this time he began his work on the spoon bill or paddle fish, Polyodon. He accumulated much material on this extraordinary form, but, unfortunately, the greater part was never published. His published papers dealt chiefly with leeches and fishes.

In addition to his scientific interest, Professor Nachtrieb had a warm interest in the whole of human life

which manifested itself in many ways. He was active in church work. He was instrumental in establishing the Minnesota Chapter of the Psi Upsilon fraternity. He was one of the most active members of the General Alumni Association of the University of Minnesota, which was organized at a meeting called by him in 1904 and whose president he became for the following eleven years. He was a leader in many other movements, the purpose of which was to improve the university.

Thus a long and beautiful life of service has come to its close. Professor Nachtrieb will be long and gratefully remembered by the university to which he devotedly gave his life work. And he will be affectionately remembered by those of us fortunate enough to have known him as a beloved teacher, a wise counselor and a loyal friend.

D. E. MINNICH

UNIVERSITY OF MINNESOTA

RECENT DEATHS

DR. WADE H. BROWN, pathologist, member of the Rockefeller Institute for Medical Research at Princeton, N. J., died on August 4 at the age of sixty-three years.

DR. WILLIAM JESSE GOAD LAND, professor of botany at the University of Chicago until his retirement with the title emeritus in 1931, died on August 1 in his seventy-seventh year.

DR. CLARENCE ERROL FERREE, formerly professor of physiological optics and director of the research laboratory of physiological optics at the Johns Hopkins University, died on July 26 at the age of sixty-five years.

DR. JAMES HAYDEN TUFTS, professor of philosophy at the University of Chicago, who retired in 1930 with the title of emeritus, died on August 5. He was eighty years old.

DR. EDWIN W. MILLER, associate professor of mathematics at the University of Michigan, died on July 23, at the age of thirty-seven years.

DR. C. C. BUNCH, research professor in education of the deaf in the School of Speech at Northwestern University, an authority on otology and audition, died on June 14 at the age of fifty-seven years.

SIR FRANCIS EDWARD YOUNGHUSBAND, explorer of Tibet and northern India, died on July 31 at the age of seventy-nine years.

AN Associated Press dispatch reports the death at the hands of the Germans of eight Polish scholars and artists. Among them were Aleksander Patowski, formerly chairman of the Polish Geographic Society and counselor of the former Polish Ministry of Education in Warsaw, and Antoni Nisezorkiewiez, custodian of the National Museum of Warsaw.

SCIENTIFIC EVENTS

THE OXFORD INSTITUTE OF RESEARCH IN AGRICULTURAL ENGINEERING

THE *Times*, London, points out that the Agricultural Machinery Development Board for Great Britain, which was set up at the beginning of this year to arrange for the testing of agricultural machinery and implements and to consider questions of uniformity and standardization, the provision of educational and advisory facilities, and any matters relating to the mechanization of agriculture, requires a highly qualified staff of agriculturists and engineers with adequate workshop facilities. A National Institute of Agricultural Engineering is accordingly being set up at Askham Bryan, near York.

The nucleus of the institute is the Institute of Research in Agricultural Engineering at Oxford, which the University of Oxford has handed over to the Ministry. S. J. Wright, the director of the Oxford institute, has been appointed director of the new institute. The staff will be considerably strengthened and adequate workshop facilities provided. The institute will be housed temporarily during the war in buildings belonging to the Yorkshire Council for Agricultural Education, but when these have to revert, after the war, to their original purpose, it is intended to build a permanent home for the institute on a site near the temporary accommodation.

The main functions of the new institute will be to act as a general clearing house for information about agricultural machinery and its use, to carry out tests or demonstrations of new or improved implements, to undertake experimental and demonstration work on the better utilization of existing equipment, and to fill the gap between inventor and manufacturer by putting new ideas into practical shape and constructing the prototype machine.

THE HEBREW UNIVERSITY OF JERUSALEM

DR. J. L. MAGNES, president of the Hebrew University, has been appointed chairman of the Scientific Advisory Committee established by the War Supply Board for the purpose of investigating scientific problems in connection with the war effort. Professor L. Farkas, of the department of physical chemistry, is secretary of the committee. The scientific departments of the university are giving increased aid to industrialists, farmers, physicians and others in the performance of essential wartime functions.

American Friends of the Hebrew University report the scientific work being carried forward at the university as follows:

Industrial Research. Imports of materials required in industry having been reduced to minimal proportions, the manufacturers of Palestine are seeking to substitute such materials with local products. Many manufacturers have turned to the university for advice. A large number of factories are now using processes worked out for them in university laboratories.

Hormones and Vitamins. A recent instance of assistance to manufacturers is that of preparations of hormones and vitamins, previously imported, which have been developed from local substances in the laboratory of physiology. Several of these preparations are now being produced in commercial quantities. In this way a shortage of important drugs has been relieved and a stimulus given to the young pharmaceutical industry of Palestine.

Insulating Material. Inventors of a new insulating material made of papyrus from the Huleh swamps in Upper Galilee are receiving help from the department of physics in working out the technical manufacturing processes.

Chemical Research. Possibilities of developing basic chemical industries in Palestine are being closely studied in the university laboratories, and small model plants have been erected where graduate students of the university participate in the research work. One of these plants is being used by the department of inorganic and analytical chemistry in the production of sulfuric acid, an essential element of production which was imported before the war.

Scientific Apparatus. Still another way in which Palestinian industry is served by the university is in the construction of precision scientific apparatus and instruments which were imported before the war and which are now being made nowhere in the Middle East except in the laboratories and workshops of the university. The university participated in the Palestine Industrial Exhibition in Cairo last summer so that the manufacturers of other Middle Eastern countries might become aware of its industrial services. In a broadcast from Jerusalem on December 8 D. de Betherl, officer in charge of the Cairo Exhibit, lauded the "astonishing scientific and technical resources of Palestine, and particularly of the Hebrew University and its research institutes."

Nutrition. The department of hygiene and bacteriology has assumed as one of its chief tasks the creation of minimal wartime diets. The department also gives close scrutiny to foodstuffs offered for sale in wartime and to advising the Palestine population in regard to diets suited to local conditions of climate. Professor I. J. Kligler, head of the department, is chairman of the Nutrition Committee of the Jewish Agency's Economic Research Institute.

Courses for Physicians. Intensive courses for Palestinian physicians and for physicians of the military troops stationed in Palestine are being given under the joint auspices of the Hebrew University Medical School and the Rothschild Hadassah University Hospital. Professor Saul Adler, head of the department of parasitology, has lectured on the diagnosis of malaria; Dr. Dov Ashbel, head of the meteorological laboratory, on the influence of climate on health; Dr. E. Wertheimer, professor of pathological physiology, on recent developments in biochemistry; Professor Dybowski, of the department of parasitology, and Dr. G. Witenberg, lecturer in helminthology, on tropical diseases; Dr. I. Leibowitz, acting head of the department of chemistry in the Cancer Research Institute, on nutrition. Clinical lectures were given by Professor A. Feigenbaum on diseases of the eye; by Dr. J. Kleeberg and Dr. M. Rachmilewitz on endemic diseases, and Dr. B. Gruenfelder on children's diseases.

New School of Pharmacology. The Hadassah University Pharmacological Institute, opened in May, is meeting war needs and is supplementing shrinking drug supplies threatening to create health hazards in Palestine. The institute has launched a program of clinical research laboratory work in the extraction of vitamins, hormones and allied substances. Established by Hadassah, the new institute is staffed by investigators associated with the Hebrew University and the Rothschild Hadassah University Hospital.

Agriculture. At the beginning of the winter term, eighteen students of agriculture, who had taken the required courses in natural science for two years, were placed in several settlements for a year's practical training on the land. The year of practical work will be followed by two years' study of agricultural science in Rehovoth.

THE HANDBOOK OF SCIENTIFIC AND TECHNICAL SOCIETIES AND INSTITUTIONS OF THE UNITED STATES AND CANADA

THE National Research Council has recently issued the fourth edition of a "Handbook of Scientific and Technical Societies and Institutions of the United States and Canada" (National Research Council *Bulletin* No. 106, January, 1942; 389 pages). The United States section contains information on 1,269 societies, associations and similar organizations in the natural sciences and related fields that contribute to the advancement of knowledge through their meetings, publications and other resources. There are also included a number of more general organizations and special institutions supporting scientific research, as well as the constituent or affiliated societies of the three other national research councils of the United States—the American Council of Learned Societies, the American Council on Education and the Social Science Research Council. The Canadian section, compiled through the cooperation of the National Research Council of Canada, contains information concerning 143 organizations.

The handbook gives, in most cases, the president and secretary of the organization; the history, object,

membership, meetings, research funds and serial publications. A subject index to each section (United States and Canadian) includes a classification of the activities, funds, periodicals and changes of name as reported in the history. The fourth edition has a personnel index also for each section.

The information for the fourth edition was furnished by the organizations during the period from July 1, 1941, to January 15, 1942.

THE REORGANIZATION OF THE BUREAU OF MINES

Chemical and Engineering News gives an account of the reorganization of the essential operating structure of the U. S. Bureau of Mines to speed the expanded program of providing strategic and critical minerals for the nation's war needs. Three regional offices are being established at Salt Lake City, Utah, for the western states; at Rolla, Mo., for the central states, and at College Park, Md., for the eastern and southern states. Each office will be headed by a regional engineer and an assistant regional engineer, whose functions will be to supervise, initiate and execute approved investigations leading to the more rapid use of mineral resources in the region under their supervision. Under jurisdiction of the regional engineers will be district engineers assigned to states or districts within the respective regions, project engineers, other technologists and scientists and clerical and laboratory help. The regional engineers, under terms of the order, will take over all the functions and duties in the field previously assigned to the Mining, Metallurgical and Nonmetals Divisions of the Technologic Branch, which are now abolished. To advise the office of the director and to perform fact-finding functions and handle reports from the regional engineers, a Resources and Laboratories Service, containing a Mineral Processes Division, a Mining Division and a Laboratories Planning Division, has been established with a small staff in Washington.

The order also provides for the establishment of a Fuel and Explosives Service within the bureau, which will take over the Coal Division, the Petroleum and Natural Gas Division and the Explosives Division, all of which were part of the abolished Technologic Branch. Operation of the helium plant at Amarillo will be under the jurisdiction of the Petroleum and Natural Gas Division, as formerly. All laboratories working exclusively on petroleum or exclusively on coal will also operate under the chief of the Fuels and Explosives Service, as will sections of other laboratories devoted to petroleum, gas or coal. Other laboratories are transferred to the appropriate regional offices.

The Health and Safety Service of the bureau remains unchanged and will continue to include the Health, Safety, Coal Mine Inspection, Explosives Control and Mineral Production Security Divisions.

It is also reported in *Chemical and Engineering News* that a $500,000 electro-development laboratory, where U. S. Bureau of Mines metallurgists plan to study the recovery and processing of minerals from the Pacific Northwest with electrical energy from Bonneville and Grand Coulee Dams, will be established in that region within the near future. With part of the funds appropriated by Congress for the Interior Department, the bureau proposes to build and operate the new laboratory somewhere within a reasonable distance of the two government power plants to provide a long-term and diversified market for large supplies of energy. As soon as a location is selected—probably within a radius of 200 miles of the Bonneville and Grand Coulee Dams on the Columbia River—erection of the laboratory will be started.

The new station will be known as the Northwest Electro-Development Laboratory and will be staffed by 40 or 50 metallurgists and assistants. It will be equipped with electric furnaces and electrolytic cells of various types, ore-crushing and concentrating machinery, chemical laboratory and machine shop equipment and other miscellaneous installations. Operation of the completed laboratory will be in charge of R. S. Dean, assistant director of the bureau, with headquarters in Washington, D. C.

Investigations will be directed, among other things, toward improving existing or developing new methods of recovering magnesium metal from magnesite deposits. Production of aluminum from the abundant clays and alunite of that region will be probed thoroughly, as will methods to produce ferroalloys from tungsten, vanadium, manganese and chromium ores.

THE AMERICAN STANDARDS ASSOCIATION AND THE DEVELOPMENT OF WAR STANDARDS

THE Federal Government has entered into a contract with the American Standards Association for the use of the facilities of the association in the development of emergency or "war" standards for the War Production Board and the Office of Price Administration. The contract is being executed by the Office of Emergency Management on behalf of the War Production Board and the Office of Price Administration. Under it the American Standards Association is to provide services in creating standards which include one or more of the following items, and any other assignments or projects which may be requested by the Government which come within the scope of the association.

Nomenclature

Uniformity in dimensions to provide for interchange-

ability of parts and supplies or the interworking of apparatus
Specifications for materials and products
Methods of test or inspection
Methods of rating machinery or apparatus
Safety standards
Rules for the operation of apparatus or machinery
Concentration upon the optimum number of types, sizes, grades and colors.

The Simplification and Radio branches of the War Production Board and the Standards Division of the Office of Price Administration will supervise the work for the Government.

Under the contract the association will be reimbursed by the Government for the actual cost of the work undertaken specifically for the War Production Board and the Office of Price Administration. The object of the work is to further the war effort by making available to government and industry standards fitted to the present situation, so as to conserve scarce materials, to simplify production, to increase productive capacity and to conserve man-power. As outlined in the June issue of *Industrial Standardization*, the association is now engaged on more than thirty of these emergency projects, and the number of such undertakings is increasing steadily. Among these are specifications for radio materials and parts, requirements for gas ranges and hot water heaters, specifications for protective footwear, packages for electronic tubes and screw threads for high temperature bolts.

The contract is limited to $90,000 in any one fiscal year. Of this sum $60,000 is to be supplied by the War Production Board and $30,000 by the Office of Price Administration.

IN HONOR OF DR. MARSTON TAYLOR BOGERT

HONORARY membership in the Society of Chemical Industry, as already noted in SCIENCE, was on July 10 conferred by order of the council on Dr. Marston Taylor Bogert. The citation of the council reads:

MARSTON TAYLOR BOGERT, Professor Emeritus of Organic Chemistry at Columbia University, in commemoration of his life-long work as an inspiring teacher, a brilliant research worker and writer in the field of organic chemistry which branch of the science he has enriched beyond measure.

Born in 1868 and educated at Columbia College and Columbia School of Mines, he became Professor of Organic Chemistry at Columbia University in 1904, and has spent forty-seven years of his life on the staff where he displayed all the qualities of leadership. He is an Honorary LL.D. of Clark University and an Honorary Sc.D. of Columbia University. He was awarded the Nichols Medal of the American Chemical Society in 1905 and the Priestley Gold Medal of the same Society in 1938; was President of the American Chemical Society in 1907–1909 and President of the Society of Chemical Industry in 1912–1913. He is now a member of the National Academy of Sciences, of the National Research Council, President of the International Union of Chemistry and of many other of the most important chemical bodies in America and in Europe.

THE COUNCIL in deciding to bestow this honor on the occasion of its sixty-first anniversary selected with great care one whom they considered worthy, for in addition to his valued contributions to our knowledge he has taken a lively interest in the international aspects of Chemistry and has through his genius for friendship done more than any other individual to break down the barriers of race and of prejudice.

The Seal of the Society of Chemical Industry was fixed in the presence of Wm. Cullen, *President;* L. H. Lampitt, *Honorary Treasurer;* Stanley Robson, *Honorary Foreign Secretary,* and H. J. Pooley, *General Secretary.*

SCIENTIFIC NOTES AND NEWS

MEMBERS of the committee recently appointed by President Roosevelt to report on the rubber situation, of which Bernard Baruch is chairman, are Dr. James Bryant Conant, president of Harvard University, and Dr. Karl T. Compton, president of the Massachusetts Institute of Technology.

AT the annual meeting of the Society of Chemical Industry at the Royal Institution on July 10, the Messel Medal was presented to Sir John Russell, director of the Rothamsted Experimental Station and of the Imperial Bureau of Soil Science. He made an address entitled "Chemistry and Agricultural Reconstruction." At this meeting Dr. William Cullen was reelected president. In his address he reviewed the growth of chemical industry during the last fifty years.

THE Albert Medal of the Royal Society of Arts for 1942 has been awarded to General J. C. Smuts, Prime Minister and Minister of External Affairs of the Union of South Africa. The following words will be inscribed on the medal: "Statesman. Soldier. Scientist. Philosopher." Among those awarded silver medals for papers read before the society during the past session was the Right Hon. Viscount Bennett, who gave an endowed lecture entitled "Empire Relations."

IT is reported in *Nature* that the joint committee

consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society and the Royal Scottish Geographical Society has awarded the Bruce Prize to Dr. G. C. L. Bertram for valuable biological work in the Arctic and Antarctic during 1932–37; and especially for his work as biologist with the Graham Land Expedition during 1934–37, when he took part in the sledging journey which discovered King George VI Sound.

IN addition to the medals awarded by the Royal Geographical Society that were recorded in SCIENCE last week, the Murchison Grant was given to Dr. S. W. Wooldridge and David Linton, for their work on the structure and surface features of southeastern England; the Back Grant to Surgeon-Commander Murray Levick, R.N., for his organization of the Public Schools Exploration Society, and the Gill Memorial to Lieutenant-Commander L. C. Hill, for his services to geography in command of the R.R.S. *Discovery II.*

PROFESSOR C. L. FORTESCUE, professor of electrical engineering at the City and Guilds College, London, has been elected president of the Institution of Electrical Engineers for the year beginning on September 30.

AT the Atlantic City meeting of the American Society for Testing Materials, H. J. Ball, professor of textile engineering at the Lowell Textile Institute, was elected to succeed G. E. F. Lundell as president. P. H. Bates, chief of the Clay and Silicate Products Division of the National Bureau of Standards, was chosen vice-president to serve with Dean Harvey, materials engineer of the Engineering Laboratories and Standards Department of the Westinghouse Electric and Manufacturing Company, who was elected vice-president in 1941.

THE retirement is announced of Professor Frank M. Torrence, for thirty-one years a member of the department of mechanical engineering at the Pennsylvania State College, and of Dr. Albert H. Walton, associate extension professor of psychology, a member of the college staff since 1936. Among the new appointments are Millard V. Barton, associate professor of aeronautical engineering; R. L. McCormick, research assistant in petroleum and natural gas engineering; C. G. Seashore, assistant professor of engineering extension; R. J. McCall, assistant professor of agricultural engineering extension, and E. J. Walter, instructor in physics. Leave of absence has been granted to L. L. Newman, assistant professor of fuel technology, to serve with the War Production Board, and to G. E. Brandow, assistant professor of agricultural economics, to serve as consultant in the Office of Price Administration.

DR. E. A. EVANS, JR., associate professor and acting chairman of the department of biochemistry of the University of Chicago since September, 1941, has been appointed chairman of the department.

DR. GORDON H. SCOTT, associate professor of histology at the School of Medicine, Washington University, St. Louis, has been appointed professor of anatomy at the School of Medicine of the University of Southern California.

DR. E. L. MILLER, of the department of zoology at Louisiana State University, is on leave of absence for the 1942–43 session to teach at Lawrence College, Appleton, Wis.; Dr. Russell Coco has resigned to accept a position at the Oklahoma Agricultural and Mechanical College; Dr. Harry J. Bennett is on leave to serve with the U. S. Sanitary Corps. Dr. George C. Kent, Jr., of Vanderbilt University, and Dr. Arlie C. Todd, of the University of Nebraska, will fill the first two vacancies. A successor to Dr. Bennett has not been appointed.

DR. ALBERT F. BLAKESLEE, who retired last December as director of the Department of Genetics of the Carnegie Institution at Cold Spring Harbor, L. I., has been appointed by Smith College as William Allan Neilson professor for the academic year 1942–43 and as guest professor for the two years succeeding. He will be accompanied by Miss Sophie Satina and A. G. Avery, who will continue their cooperative investigations in cytogenetics. A large greenhouse (150′ × 30′), located between Northampton and Amherst, has been rented by Smith College for these studies for the three-year period. Properly qualified graduate students, both men and women, will be accepted for work toward an advanced degree under direction of the group. A limited number of part-time assistantships will be available to exceptional students who may register in the Graduate School of Smith College without payment of the regular tuition fees. Correspondence regarding these positions may be addressed to Dr. Blakeslee at Cold Spring Harbor, L. I., until September 12, and after that date at the department of botany, Smith College, Northampton, Mass.

DR. MEYER M. HARRIS, principal research internist of the New York State Psychiatric Institute, has received an additional grant-in-aid from the Committee on Scientific Research of the American Medical Association in support of work on the role of metabolic factors in neuromuscular diseases.

DR. ELDON W. LYLE, plant pathologist in rose disease investigations at the Tyler Substation of the Texas Agricultural Experiment Station, has been transferred to the substation at Temple, Texas, to work on Phymatotrichum root rot of cotton. The position at Temple has been held until recently by Dr. C. H. Rogers, who has resigned to serve as plant

pathologist with the Coker Pedigreed Seed Company of Hartsville, S. C.

DR. JOHN L. RICE, who was succeeded on July 16 as Health Commissioner of New York City by Dr. Ernest Lyman Stebbins, has been appointed deputy health commissioner at a salary of $7,000 a year.

CHARLES A. MABEY, physicist of the Bristol Company, Waterbury, Conn., has been appointed director of the research activities of the company.

W. W. DESCHNER, of the department of chemical engineering of the University of Kansas, has been appointed head of the division of chemical design, engineering and construction at J. F. Pritchard and Company, Kansas City, Mo.

IT is reported that an expedition to study cosmic rays, sponsored by the Academy of Sciences of the U. S. S. R., led by Professor A. I. Alikhanov, will be in the field for about six weeks making observations at the high-altitude meteorological station in the Alpaz mountains.

SCIENCE SERVICE reports that four scientific men from the Argentine will make a survey of industrial utilization possibilities of farm crops and wastes in the United States. The visit was arranged with the Government of Argentina by the State Department, the coordinator of Inter-American Affairs and the Department of Agriculture. Carlos Clementino Zarate and Oscar Saturnino Mallea, of the University of Santa Fé, both of whom are especially interested in problems of farm waste utilization, and Dr. Enrique Duprat, of the University of Buenos Aires, who will look into possibilities of industrial products from corn and wheat, have already arrived. At the end of the month they will be joined by José Baialardo, chemical engineer of the University of Santa Fé. Several weeks will be spent visiting the four regional laboratories of the Department of Agriculture at Philadelphia, Peoria, New Orleans and Albany, Calif., followed by six months of intensive research at whatever laboratory and in whatever line of work each visitor may select.

A SYMPOSIUM on synthetic rubber will be held by the American Chemical Society at the Buffalo meeting on September 9. Dr. E. R. Weidlein, director of the Mellon Institute and technical consultant on rubber of the Reconstruction Finance Corporation, will speak on "The Progress of Synthetic Rubber Production"; Albert L. Elder, of the Materials Division, War Production Board, on "The Progress of Butadiene Production," and Willard H. Dow, president of the Dow Chemical Company, on "The Progress of Styrene Production."

IN addition to the Training School for Electricians, already in operation at Iowa State College, the Navy will establish a Diesel school there. The college will furnish both instruction and buildings for the school, which will open about the middle of September.

A NEW cooperative program for industry and education has been initiated for chemists at the Illinois Institute of Technology. Fifty students have entered the first academic session of a cooperative course in chemistry, after completing sixteen weeks of work in industry, while a similar group will begin study in September. The program is the first of its kind in the Chicago area, having been organized only this spring. For the last seven years a similar course has been offered in mechanical engineering. Five hundred students are now included in that program. Plants cooperating hire the students in pairs so that one works while the other studies. The plan not only allows the students to earn a large part of their expenses while completing work for an engineering degree in five years, but also gives them the advantage of actual experience in industry. Standards are high. The student must be in the upper fourth of his high-school class to be considered an applicant and must pass aptitude and general tests before being finally admitted. The academic work of the program is done at the Lewis Institute.

IT is reported in *Nature* that a Free German Institute is being founded by the science section of the Free German League of Culture in Great Britain. The aims of the institute are: to uphold and develop the valuable traditions of the Free German research work and teaching; to provide for interchange of opinion between Free German men of science and those of the United Nations; to strengthen the German refugee youth in the spirit of international understanding and to enable them to help in reshaping Germany's cultural life after the destruction of Nazism. The opening session was held on July 17, when an address was given by Dr. Joseph Needham. Further particulars of the movement can be obtained from the secretary, Free German League of Culture, 36 Upper Park Road, London, N.W.3.

DISCUSSION

SWEDISH OCEANOGRAPHIC RESEARCH IN 1941

THE rotating "inertia currents" discovered by Swedish oceanographers in the Baltic Sea in 1931 have been further studied by Dr. B. Kullenberg in this institute in collaboration with Mag. I. Hela of Havs-

forskningsinstitutet of Helsingsfors, utilizing measurements from the last international cruise in July–August, 1939. The analysis of sustained observation series, partly from anchored ships, partly by means of recording meters below subsurface carrier buoys, prove the rotating current component of 12 pendulum hours' period to be practically of the same phase across the central Baltic, from the Swedish island Öland to near the coast of Lettonia. This implies that the whole surface watermass down to the thermocline near 20m:s depth is carrying out a rotatory movement with a horizontal amplitude up to 5 kilometres. In addition tidal currents of the M_2-period with a maximum velocity of 2 cm/sec. were for the first time ascertained to occur in the Baltic.

The vacuum core-sampler constructed by Pettersson and Kullenberg has been further developed. With a 2″ tube cores up to 12 metres long have been sampled from the Gullmar Fjord (115 m), and have been submitted to pollen analysis. Also from the Baltic coast cores of 7 metres length have been sampled with a shorter tube. They show distinct varves, also such of recent date, and thus promise to allow of a linking up of the post-glacial chronology of De Geer with our time. By means of a special contrivance it has been possible to make the length of the cores agree to within a few per cent. with the depth of submergence in the deposit, the cores being thus truly representative of the stratification *in situ*.

An examination of the radium content in manganese nodules from the Challenger expedition, central Pacific Ocean, has proved the very high content of the outermost layers, 10^{-10} gr Ra/gr, to decline rapidly inwards to quite low values near the nucleus. Apparently the Ra-ions attracted by the manganese, either from the sea water or from the surrounding sediment, show the characteristic decay of 1,580 years half-period. From the figures thus interpreted the rate of growth of the nodule is estimated at 1 millimetre in from 700 to 1,500 years. The more rapid growth to the upward direction, indicated by the convex shape of the largest nodule, is probably due to the accretion of sediment from above, the rate of sedimentation being thus found of the order 1 millimetre in 1,000 to 2,000 years, apparently the first estimate of the accumulation of red clay based on measurements. The figures are subject to a final revision on the conclusion of a more detailed study now in progress, where the radium content is being related, not to the gross weight of substance but to the content of manganese.

Preliminary measurements made several years ago on the vitamin D content in diatoms, collected in larger quantities during the spring increase here, had indicated the presence of considerable amounts of the antirachitic vitamin, which were, however, much increased by exposing control batches of the same diatoms to intense ultraviolet radiation from a quartz lamp. These investigations have now been resumed in collaboration with the new State Institute for Public Health of Stockholm, Director Professor Abramsson, where biological tests were carried out with diatoms collected from Bornö Station on the Gullmarfjord. The results were negative with non-radiated diatoms, probably owing to the available quantity being rather limited, whereas the same quantity of diatoms after uv-radiation gave a relatively high vitamin content, the oil extracted being even richer in the D-vitamin than codliver oil. It therefore seems likely that the vitamin D found in many marine organisms may in fact be identical vitamin D_3 and especially that the vitamin D available in phytoplankton and hence their value as primary foodstuff for marine organisms may depend on the ultraviolet daylight penetrating into the surface layers of the sea. This also suggests the tentative explanation for the preponderance of certain year-classes of food-fishes, and all it implies for the economic yield of the fisheries, that it may be due not only to the quantity of foodstuff available during the critical weeks in the existence of the fish-larvae (when their percentage of survival is largely determined) but also to its *quality, i.e.*, to the amount of vitamin D produced in the phytoplankton by the antirachitic daylight components reaching down to the plankton-bearing layers. Further research along these lines is now in progress.

HANS PETTERSSON,
Director

SVENSKA HYDROGRAFISK-BIOLOGISKA KOMMISSIONEN AND OCEANOGRAFISKA INSTITUTET I GÖTEBORG

THE FIRST LAW OF FLUORESCENCE

THERE have been comparatively few rules and so-termed laws formulated and proved for fluorescence and phosphorescence. Probably the best known is Stokes's Law, although others of a more specialized nature may be found in the literature of the field.

In photochemistry, the very basic rule is the Grötthuss-Draper Law. Grötthuss, in 1817, while investigating the fading of alcoholic solutions of ferric chloride and other iron salts, concluded that only light which is absorbed can act chemically. This rather obvious statement, now called the First Law of Photochemistry, at first attracted little general attention. Later the Grötthuss Law was independently rediscovered by Draper, in 1843, in the course of investigations on the photochemical combination of hydrogen

and chlorine.[1] Quantitative significance was given the Grötthuss-Draper Law by Van't Hoff, in 1904, during study of substance transformations by light of different intensities.[2]

In fluorescence an analogous situation may be considered to exist. However, the most fundamental law of fluorescence, and therefore of fluorochemistry, has not yet been formally defined, *i.e., energy must be absorbed by a luminescent system before emission can occur.* This patent statement most evidently concerns Stokes's Emission. In this connection, the exact status of Anti-Stokes's Emission and resonance radiation may provoke contention when close consideration is given this First Law of Fluorescence.

JACK DE MENT

The Mineralogist,
PORTLAND, OREGON

CEMENTING SINO-AMERICAN FRIENDSHIP

A STATEMENT contained in the recent letter by Egbert H. Walker on the subject of "Cementing Sino-American Friendship" possibly should be expanded. Dr. Walker's letter was concerned with the possibility of the collection of reprint material to be used as gifts to destitute Chinese libraries. He stated, "There seems at present to be no organization receiving and storing such unneeded literature for future distribution." His statement is true in respect to reprint material alone, but there is an organization in existence working on the question of preservation of scholarly and scientific materials for foreign libraries.

The American Library Association as early as December, 1940, created a Committee on Aid to Libraries in War Areas, headed by John R. Russell, librarian of the University of Rochester (reported in SCIENCE, March 6, 1942). During the past year and a half the committee has been working toward that time when reconstruction of foreign libraries can become possible. A rather extensive purchase program has been in process since July, 1941, and a campaign for gift material has been inaugurated on at least a small scale. The committee has had considerable publicity aimed at the conservation of important American scholarly journals, and through the publicity has received gifts from many institutions and individuals interested in the rebuilding of research resources in foreign countries.

The cooperation of a small group of American libraries scattered throughout the country has been enlisted on the question of storage space, and as gifts of journals have been offered, the committee has been able to issue shipping instructions for the transfer of this material to temporary storage, pending that time when foreign distribution can be accomplished.

With rather limited storage space, the committee has been doubtful as to the wisdom of attempting at the present time to collect book material and reprints. Considering the present state of the international situation, it is obvious that storage of this material may have to be for a matter of years, and although we can be sure what journal material will be of importance to foreign libraries, it is not as easy to predict the value of book and reprint material.

The committee would be very grateful for assurances that scholars in this country are keeping this future need in mind and are not destroying either journal, book or reprint material which they feel will be of value. In those instances where personal storage of this material is not possible, the committee would be very grateful for reports of what publications might be available and would undoubtedly be able to reach some satisfactory solution of the storage problem.

WAYNE M. HARTWELL,
Executive Assistant to the Committee
RUSH RHEES LIBRARY,
UNIVERSITY OF ROCHESTER

RESEARCH AS USUAL

ALTHOUGH few of us realize what the phrase means, we have been rightly told that "this is total war." As yet we have been called upon for only a small fraction of the sacrifice that will surely be necessary before the struggle is over. The longer we postpone doing the inevitable, the higher the cost will be, just as we are now paying heavily for our lack of foresight and sagacity a few years ago.

In this country a vast amount of time is still being spent on things that are of no immediate importance. A goodly fraction of that wasted effort could be devoted to work that will promote the success of our war struggle. In so far as it could be, it should be. To do anything else is at best short-sighted and at worst definitely unpatriotic.

Although many scientists in this country have already turned their attention to research work tributary to the war, there are still thousands who are going along just as in peace times, digging up facts that have no relation to the present emergency, studying problems not even remotely concerned with it, and burdening the mails with papers and books that deserve but little attention until this war has been won and our civilization saved from utter ruin.

Scientific research is of prime value in this crisis. Many of its good results are already well known. It is even possible that a single scientific discovery may tip the scales in favor of victory. But if one's accustomed field of research happens to be unrelated

[1] J. Draper, *Phil. Mag.*, 23: 401, 1843.

[2] F. F. Heyroth, "The Chemical Action of Ultraviolet Rays," 2d edition, page 206. New York: Reinhold Publishing Corporation. 1941.

to any war activity, he can surely turn part of his attention to some of the many other necessary things that any educated person can do.

Of course this is not a suggestion that all scientific work which is not directly connected with the war should be even temporarily abandoned. There are some investigations under way which may be important later on and which if not finished now will be entirely fruitless. There are certain projects that must be executed now or never, such as the geological survey in the valley of the Colorado River, that was made a few years ago before the rising waters of Lake Meade covered the scene forever. There may also be a few scientists who would be of so little value in any other occupation that they might as well continue at their usual work.

When allowances have been made for such exceptions, there still remains a large fraction of the available energy of the scientists of the country that could and ought to be diverted to the main purpose of saving the only type of civilization in which science can flourish and human happiness be widely attained.

ELIOT BLACKWELDER

STANFORD UNIVERSITY

QUOTATIONS

SOCIAL MEDICINE

THE history of medicine is the story of a discontent which, from age to age, has infected the minds of practising physicians. One of the earliest manifestations of this discontent was the theory of the "four humours" enunciated by Hippocrates of Cos, in an attempt to explain the phenomena of disease and so to effect an improvement in therapy. Hippocrates made cure his measure of the understanding of cause and thus set the doctor upon the long way which, at this hour, he is still diligently treading. Those who followed have not at any time abandoned the Hippocratic outlook; but they have enlarged and broadened it so that the ideal of cure has become associated in their minds with the higher ideal of prevention. The names of Harvey, Sydenham, Jenner, the Hunters, Pasteur and Lister are held in honor as the architects of a world delivered from disease rather than of a world in which sick men can be restored to health. In the field of tropical medicine prevention has already so far eclipsed cure as to present a dazzling prospect of achievement; in the other fields the study of sources is reaching out towards a new vision of the doctor and his work. As the causes of disease are more precisely determined, it is seen that removal of these causes is the concern not of doctors only but also of all their patients, actual and prospective, that is to say of Government and the community.

It is this view of the matter which endows the great scheme of research founded by Lord Nuffield at Oxford six years ago with its peculiar interest and importance. Lord Nuffield, by establishing a new study of the causes of disease in surroundings calculated to stimulate the imagination and whet the edge of curiosity, effected such a welding of science and sociology as even the most optimistic had not dared to hope for within the compass of a generation. The Oxford school began to express the view, illustrated in a recent Harveian oration by Sir Farquhar Buzzard, that social medicine has been and is being neglected in this country, and that the time has come for an organized investigation of the social factors in many obscure problems of causation by a force of doctors specially trained for the purpose. Action has now followed. With the cordial approval of Lord Nuffield, the Nuffield Provincial Hospitals Trust has decided to devote the sum of £10,000 a year, for ten years in the first instance, to the creation of a university professorship of social medicine in Oxford University, and to the foundation of an institute in which the professor will work.

The purposes of the new institute are three-fold—to investigate the influence of social, genetic, environmental and domestic factors on the incidence of human disease and disability; to seek and promote measures, other than those usually employed in the practice of remedial medicine, for the protection of the individual and of the community against such forces as interfere with the full development and maintenance of man's mental and physical capacity; and, if required by the university to do so, to make provision in the institute for the instruction in social medicine of students and practitioners approved by the board of the faculty of medicine in the university. A chief merit of this plan is the promise which it affords of a solid foundation for future legislative action. For the truth must be faced that such a foundation does not exist at present and can not be attained except by diligent work. Schemes of reform or coordination are likely to fail of their object if initiated hastily without a true understanding of the issues involved and the difficulties certain to be encountered. Social medicine is not an exclusive province of government; it belongs also to all the local areas and even to all the workers in these areas. Only experience can direct the march of a progress which must in present conditions be pioneering work. The trail must be blazed. Upon the new institute at Oxford University will devolve the heavy responsibility and the high honor of blazing it.—*The Times, London.*

SCIENTIFIC BOOKS

THE RAT IN LABORATORY INVESTIGATION

The Rat in Laboratory Investigation. By JOHN Q. GRIFFITH and EDMOND J. FARRIS, editors, and thirty contributors. 488 pp. 178 illustrations. J. B. Lippincott Company, 1942.

THIS book, being the product of many workers, has all the strength and weakness of that form of writing. Each author treats his topic from his own point of view and with little regard for the contributions of the others. The chapters are therefore of very different lengths—5 to 76 pages—quite regardless of the relative importance of the topics, and the general treatment varies in the same way. Some of the chapters are excellent—others much less so, but in general the average is high.

An inspection of the various chapters shows that, with few exceptions, they are concerned with experimental procedures. The first of these, by Edmond J. Farris (17 pages), gives the standard procedures of the Wistar Colony, now perfected after years of experimentation. It is called "Breeding the Rat." The next, "General Methods," by John Q. Griffith (5 pages), which deals almost entirely with anesthesia, follows. Then comes one of the non-experimental chapters on "Gross Anatomy" (28 pages), by Eunice C. Green, a brief account of normal structures in preparation for later chapters. An introduction to the "Experimental Methods and Rat Embryos" (28 pages) by J. S. Nicholas comes next. This is largely an account of normal development. Then follows a treatise (36 pages) by Richard H. McCoy, dealing with the dietary requirements of the rat. In this the various substances are considered separately, with a summary at the end and a long, condensed bibliography. Following this is an account of the teeth (63 pages), by Isaac Schour and Maury Massler, including the effects of various agents upon their development. This has also a fairly long bibliography. Then comes a brief account (13 pages) by Thos. E. Machella and J. Q. Griffith on "The Digestive System," which is almost entirely experimental. This is followed by another account on "Metabolism" (13 pages), by C. Jelleff Carr and John C. Krantz—carbohydrate, fat nitrogen and respiratory metabolism—with reference, in the final sections, to the effects of operative procedures and drugs upon metabolism. A short chapter (8 pages) on the "Central Nervous System," by W. A. Jeffers, J. Q. Griffith and E. Roberts, deals with various operations. Then follows a long section (76 pages) on "Techniques for the Investigation of Psychological Phenomena," by George L. Kreezer, well organized alphabetically under headings, with cross references. This has the longest bibliography of any in the book. Next there is a chapter on the "Circulatory System" (17 pages), by J. Q. Griffith, W. A. Jeffers and E. Roberts, in which are considered various experimental procedures. A short chapter (7 pages), dealing with the use of the rat in biological assay, follows. Then comes a long chapter (55 pages) on "Dosage of Drugs," by Harald G. O. Holck and Donald R. Mathieson. This is largely a tabular arrangement, preceded by a discussion of some general conditions and followed by a long bibliography. The chapter on "Haematology of the Rat," by Adolph J. Creskoff (16 pages), takes up methods and draws comparisons with human blood. The fifteenth chapter deals with the use of x-rays (16 pages) and is largely a series of pictures. The next section deals with the topic of "Surgery" (19 pages), by Dwight J. Ingle, John Q. Griffith, W. A. Jeffers, M. A. Lindauer, H. U. Hopkins and Albert Segaloff, and presents a series of operations in detail. Then comes a chapter given to "Histological Methods" (7 pages), by W. H. F. Addison—fixing, imbedding and staining. "The Osseous System," which follows (22 pages), by R. M. Strong, is general in character and consists in the description of methods for gross and microscopic preparations. The chapter on "The Eye" is the shortest in the book (5 pages) and is by W. E. Fry. Then comes a section on the "Protozoan Parasites" (13 pages), by D. H. Wenrich, divided into those of the digestive tract and of the blood and tissues. Following this is a chapter on "Metazoan Parasites" (14 pages), by Herbert L. Ratcliffe, arranged according to the type of animal parasites. Finally there is a chapter on "Spontaneous Diseases of Laboratory Rats" (15 pages), also by Herbert L. Ratcliffe, in which are considered various rat diseases.

From this brief review it is apparent that the present work is a practical compilation of some of the more important phases of rat technique. It deals almost entirely with methods and procedures—it is a worker's hand book and, as such, forms an indispensable guide. In the very nature of its preparation it can not be complete and well rounded, and even, in the detail of bibliography, each author follows his own ideas. The many illustrations are good and the format and typography are excellent.

C. E. MCCLUNG

STELLAR DYNAMICS

Principles of Stellar Dynamics. By S. CHANDRASEKHAR. x + 251 pp. Illustrated. Chicago: University of Chicago Press. $5.00.

THE latest addition to the Astrophysical Monographs sponsored by the *Astrophysical Journal* is an important volume by Dr. S. Chandrasekhar, of the University of Chicago and the Yerkes Observatory. Through his studies of the dynamics of a rotating

galaxy and of the dynamics and statistics of encounters between stars Dr. Chandrasekhar has become one of the leading authorities in the field of galactic dynamics. In the new volume he has blended his own researches and those of others in a well-rounded book, which should for many years to come be "must" reading for every prospective student of galactic structure and dynamics.

The book opens with a chapter on "Kinematics." Beginning with a brief analysis and descriptions of the properties of stellar motions for the regions in the immediate vicinity of the sun, the author describes the phenomena of galactic rotation and of the asymmetry in stellar motions for high velocity stars. The chapter closes with a survey of the properties of external galaxies and a brief mention of some characteristics of star clusters.

In the second chapter, "The Time of Relaxation of a Stellar System," we find a clear discussion of the effects of stellar encounters. The presentation follows closely that of a series of papers by Chandrasekhar and Williamson. Even in the two-body approximation the problem is quite complex. No attempt has been made to extend the analysis so as to include the effects of multiple encounters by adapting the theory of fluctuations to the stellar case. A first trial in this direction has recently been made by Chandrasekhar and von Neumann, but the two-body approximation will probably remain important for rough estimates for many years to come.

The dynamics of a stellar system with differential motions, such as our own galaxy, is presented in the third chapter. The treatment follows closely that of the author and many astronomers will be delighted to have here an authoritative summary of Chandrasekhar's earlier papers.

The discussion of the dynamics of stellar systems is contained in the fourth chapter, in which special attention is given to the dynamical interpretation of spiral structure. The sections on Lindblad's theory of spiral structure, which present a fair and critical evaluation of current achievements and remaining difficulties, will probably be more widely read than any other part of Chandrasekhar's volume.

The book closes with a chapter on the dynamics of star clusters. The problem of globular clusters receives only scant attention, but the treatment of galactic clusters is quite complete and excellently written. In this chapter Chandrasekhar indicates in which way the theories for the dissolution of galactic clusters under the influence of the shearing forces of galactic rotation must be adapted in order to include the effects of encounters between cluster members.

At the conclusion of every chapter there appear bibliographical notes that contribute much to the general value of the volume. A detailed subject index and some appendices will undoubtedly prove very useful.

Chandrasekhar's volume comes at a time when there exists a real need for a book on stellar dynamics. Research in this field has recently developed along rather divergent lines and none of the books published during the past ten years has succeeded in providing a unified treatment. Chandrasekhar's book does this for the first time. Some of us who have worked in the field of galactic dynamics might here and there have preferred a somewhat different approach, but when it comes to judging the book as a whole we all pay our respects to the skill and insight of the author.

This book should exert a profound influence on the future developments in the field of galactic dynamics. I can recommend its study unreservedly to newcomers in the field and to those who already have a passing acquaintance with its problems. The experts can profit from reading it. If I were stranded in a far-off prison camp where I would be allowed one book I would ask for Chandrasekhar's volume. I am sure that per ounce of paper it would provide the most stimulation for continued research in theoretical astronomy.

BART J. BOK

HARVARD COLLEGE OBSERVATORY

SPECIAL ARTICLES

TREATMENT OF EXPERIMENTAL RENAL HYPERTENSION WITH VITAMIN A

RECENTLY Pena and Villaverde reported favorable results in the treatment of essential hypertension in man with large doses of vitamin A orally.[1] Several case histories confirmatory of this finding have been reported to the senior author by medical colleagues. In view of these reports and the many similarities between experimental renal hypertension in the dog and essential hypertension in man, inclusive of a probable partial common pathogenesis, we have studied the effect of vitamin A by mouth in experimental renal hypertension in dogs. This report summarizes our preliminary results.

Five dogs were rendered hypertensive by the Goldblatt technique[2] and the resulting hypertension was permitted to stabilize over a period of five to eight months. Mean blood pressure readings were obtained by puncture of a femoral artery two to three times a week. Studies on the blood urea nitrogen, urinalyses and determinations of body weight were made at monthly or bimonthly intervals. Three of the dogs

[1] J. Govea Pena and M. Villaverde, *Rev. Cubana Cardiol.*, 2: 322, 1940.

[2] H. Goldblatt, J. Lynch, R. F. Hanzal and W. W. Summerville, *Jour. Exper. Med.*, 59: 347, 1934.

were treated daily with 200,000 units of vitamin A dissolved in 1 cc of sesame oil[3] by mouth for three months, followed by 400,000 units of vitamin A in 2 cc of sesame oil for an additional three months. The other two dogs served as controls and were given oral daily doses of 1 cc of sesame oil for three months, to be followed by 2 cc of sesame oil for another three months. A limited number of blood serum vitamin A determinations (method of McCoord and Luce-Clausen[4]) were made on these five animals and on two untreated normotensive and two untreated hypertensive dogs.[5]

Striking reductions in the blood pressures were observed in each of the three dogs treated with vitamin A. The results for the first dog, which are typical for the other two animals, are illustrated in Fig. 1. The normotensive blood pressure range for this dog, which weighed 16 Kg., was 100–120 mm Hg. Following bilateral constriction of the renal arteries, the dog developed a hypertension which ranged from 150–180 mm Hg. during the succeeding eight months. During the second week of vitamin A therapy, the blood pressures of the animal decreased approximately 20 mm Hg. and then ranged from approximately 120–140 mm Hg. for the remainder of the first three months of treatment. Three additional months of therapy just completed at the increased dosage of 400,000 units of vitamin A daily resulted in a further gradual reduction in blood pressure to the normotensive level of 100–120 mm Hg. The blood pressures of the second dog, which weighed 12 Kg., were similarly reduced from a hypertensive range of 190–210 mm Hg. to the pre-constriction normotensive level of 130–140 mm Hg. The blood pressures of the third dog weighing 15 Kg. were decreased from a hypertensive range of 150–170 mm Hg. to a level of 130–150 mm Hg. during the second week of vitamin A therapy and have remained in this range to date (third month of treatment).

The two control dogs treated with sesame oil have thus far shown no significant changes in their hypertensive levels of 150–170 mm Hg. and 160–180 mm Hg., respectively. Moreover, we have never seen spontaneous blood pressure decreases similar to the reductions observed in the three dogs treated with vitamin A in 75 renal hypertensive dogs during the past three years.

Serum vitamin A determinations on the untreated normotensive and hypertensive dogs showed values of 40–70 units per 100 cc. During vitamin A therapy the serum vitamin A values of the three dogs varied from approximately 500–3,000 units per 100 cc, whereas the two dogs given sesame oil ranged from 40–70 units per 100 cc.

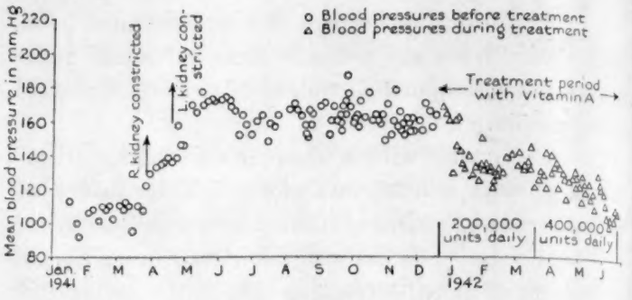


FIG. 1.

No toxic effects from the vitamin A therapy were detected in any of the animals, although our present observations do not rule out this possibility. The appetites of the dogs remained excellent, their weights constant, and their blood urea nitrogens and urines normal throughout. The two dosage levels of vitamin A used were somewhat less than 1/20 and 1/10 of the amounts reported toxic for rats by some workers[6, 7, 8] but less than 1/100 and 1/50 of the toxic levels reported by others[9, 10] who contend that the lower values of the former investigators are due to impurities.

The mechanism of the striking reductions in the blood pressures of these three renal hypertensive dogs by high dosage vitamin A therapy is obscure. We have seen no evidence of hypovitaminosis A in experimental renal hypertension in dogs, and the few serum vitamin A determinations reported above are confirmatory in this respect. The fact that vitamin A in high dosage has been shown to raise the urea clearance of dogs 40 per cent. above normal[11] suggests that vitamin A in large doses may disturb the pathophysiologic pressor mechanisms produced by renal artery constriction. The antihypertensive action of vitamin A in experimental renal hypertension may, of course, be totally unrelated to its specific vitamin effects. Indeed, one or more chemically related compounds with little or no vitamin A action may prove to be more effective than vitamin A as hypotensive agents. The vitamin A preparation used contained traces of impurities. The unlikely possibility that one or more of these impurities is responsible for the reductions in blood pressure must be investigated.

In any event, we purpose to enlarge considerably this preliminary study of vitamin A in experimental

[3] Generously supplied by Dr. J. B. Rice, Department of Medical Research of the Winthrop Chemical Company.

[4] A. B. McCoord and E. M. Luce-Clausen, *Jour. Nutrition*, 7: 557, 1934.

[5] We are grateful to Dr. H. P. Popper, of the Department of Pathology, for these determinations.

[6] G. Domagk and P. von Bobeneck, *Virch. Arch. of Path. Anat.*, 290: 385, 1933.

[7] W. von Drigalski, *Klin. Woch.*, 12: 308, 1933.

[8] H. Popper and S. Brenner, *Jour. Nutrition*, 23: 431, 1942.

[9] E. B. Vedder and C. Rosenberg, *Jour. Nutrition*, 16: 57, 1938.

[10] I. Ikegaki, *Ztschr. f. Vitaminforsch.*, 7: 113, 1938.

[11] R. C. Herrin and H. J. Nicholes, *Am. Jour. Physiol.*, 125: 786, 1939.

renal hypertension and also to determine the possible antihypertensive effects of other compounds chemically related to vitamin A.

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RENAL HYPERLIPEMIA IN DOGS

OBSERVATIONS made in studies on children suffering from nephrosis gave rise to the question whether or not the kidney itself may exert a regulatory influence on the blood lipids, disturbance of which could lead to the hyperlipemia manifested in nephrosis. This problem was studied by determining the content of total fat and of total and free cholesterol in the blood serum of 18 dogs which had been subjected to nephrectomies[1] or to subcutaneous injections of bichloride of mercury, uranium nitrate or potassium bichromate.

Bilateral nephrectomy, performed on three dogs, was followed by a continuous rise in the level of serum cholesterol. The effect observed in one of these dogs after the second kidney had been removed is shown in

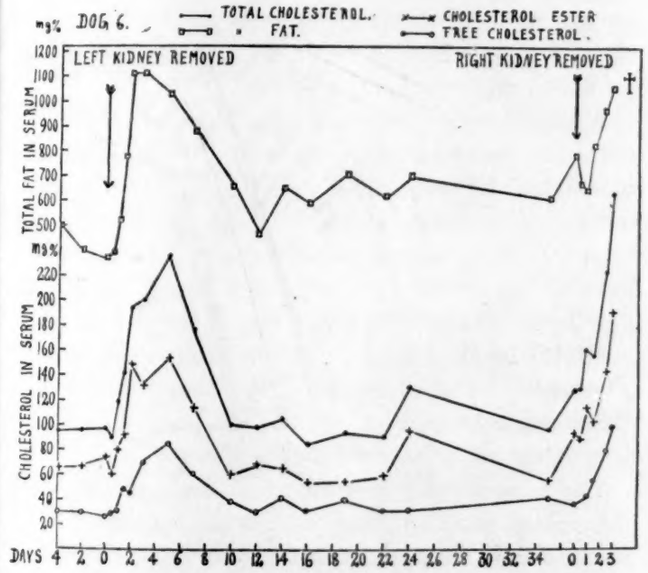

FIG. 1

Fig. 1. It can be seen that the total fat content increases beyond the extent that could be accounted for by the increase in cholesterol, thus indicating that lecithin and probably also fatty acids and neutral fat participate in this increase.

The effect of unilateral nephrectomy was studied in two dogs. In both animals the level of blood lipids rose for from 4 to 7 days and then returned to normal in 12 or 14 days after the operation (Fig. 1). The increase is obviously connected with the sudden removal of one kidney, while the return to normal level may well be due to the subsequent hypertrophy of the remaining kidney. A sham operation performed as control did not influence the blood lipid level.

In 10 dogs a single dose of bichloride of mercury administered subcutaneously was followed in every instance by an increase in the content of total fat as well as of free cholesterol and cholesterol ester. One lethal dose of 16 mg per kilogram of body weight led to a continuous increase until death. When a smaller dose was injected, however, the resulting hyperlipemia subsided and the values returned to normal. The results of one of the eight experiments carried out with a single injection of 5 mg of bichloride of mercury per kilogram of body weight are shown in Fig. 2. The resulting hyperlipemia is not

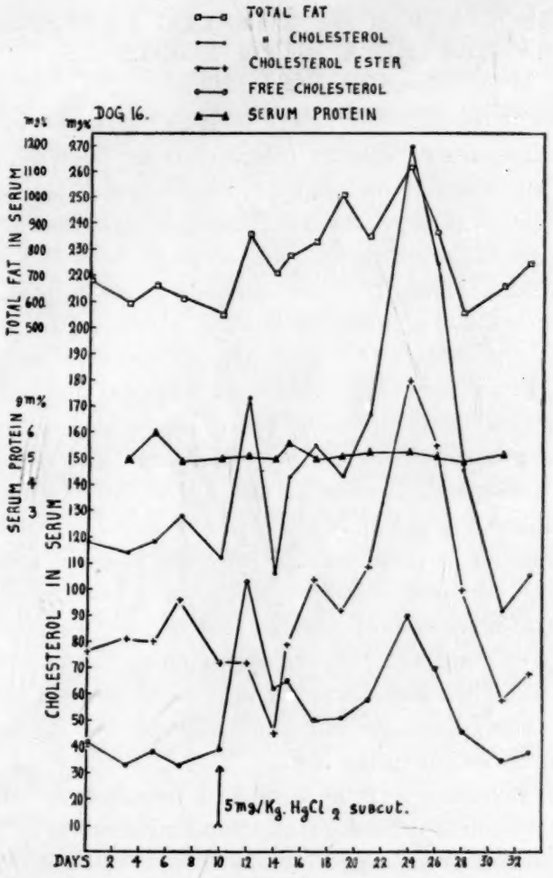

FIG. 2

accompanied by a decrease in the content of serum protein. This observation is of importance in connection with the theory which explains the hyperlipemia in nephrosis on the basis of hypoproteinemia. A smaller dose of bichloride (2 mg per kilogram of body weight) was injected intramuscularly in two other dogs twice a week for between three and four weeks. In these dogs hyperlipemia developed slowly and the level of total fat and of cholesterol continued to rise as long as the injections were given.

Subcutaneous injection of potassium bichromate (7 mg per kilogram of body weight) in one dog and of uranium nitrate (6 mg per kilogram of body weight)

[1] I am indebted to Dr. Harry Goldblatt and Dr. Joseph R. Kahn, of the Institute of Pathology, School of Medicine, Western Reserve University, for performing the operations on the dogs.

in another dog also brought about an increase in the content of total fat and cholesterol in the blood serum to over 100 per cent. of the original amount.

Conclusion: The tubular apparatus of the kidneys of dogs possesses a regulatory influence on the blood lipids such as has hitherto been unknown and is still unexplained. It is probable that the human kidney exerts the same function, but this has not yet been proved. A disturbance of this function would explain the hyperlipemia observed in nephrosis better than any hypothesis thus far advanced.

WALTER HEYMANN

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ASSOCIATION OF TOBACCO LEAFSPOT BACTERIA WITH ROOTS OF CROP PLANTS[1]

SINCE the discovery, more than 20 years ago, of the causal agents of wildfire (*Bacterium tabacum* W. and F.) and angular leafspot (*B. angulatum* F. and M.) diseases of tobacco, no satisfactory explanation of the sources of inoculum in tobacco plant beds has been advanced. Even if a new plant-bed site is used, the plant-bed soil steamed or burned, a new cotton cover used, and disease-free seed planted, angular leafspot and, to a less extent, wildfire may appear throughout an entire Burley tobacco bed or large sections of it after a few hours of cool, wet weather. The fact that the amount of disease is usually so great seems to eliminate the possibility that the bacteria might have originated in trash from a previous infected tobacco crop. One fact is known which has a bearing on the source of inoculum; namely, that one or two applications of Bordeaux mixture sprinkled on the surface of the soil when the plants are very small or even before the seeds germinate will completely protect the leaves from infection in the bed.

In searching for the source of inoculum we found that,[2] in field soils naturally contaminated with these organisms from a previous infected crop, the organisms survived the winter at least until plant-bed time, and could be isolated by proper technic. The same was true of plots of soil out-of-doors artificially inoculated in the fall. Attempts to isolate the organisms from plant-bed soil in the spring of 1941, however, where subsequently one or the other disease developed, resulted only in failure. Occasional failure also resulted in attempts to isolate the organisms from artificially and naturally contaminated soil in which cover crops were growing. These erratic results suggested that the bacteria might be living on or in the roots of cover crops in the contaminated soil and that infection of leaves in the plant bed might follow multiplication of the bacteria on the roots of young tobacco or other plants growing in the bed.

In testing this hypothesis it was found that heavy infection frequently resulted when the roots of cover crops, including wheat, barley, rye, crimson clover and vetch, were washed free from soil in running water, ground in a mortar, diluted with water and poured over the surface of artificially water-soaked tobacco leaves. The roots were obtained both from artificially contaminated soils out-of-doors and from fields where the diseases were known to have been severe in 1941. Roots of tobacco from plant beds naturally infected with wildfire or angular leafspot also gave heavy infection when washed and used as inoculum. *B. angulatum* has also been isolated from the roots of seedling tobacco plants before the disease appeared on the leaves in untreated beds, and has been isolated from the roots of tobacco plants in beds treated with Bordeaux mixture. It is likely, therefore, that both organisms may be carried from the plant bed to the field on the roots of "healthy" plants and be the source of sudden outbreaks in the field following a protracted period of wet weather.

A microscopic examination of tobacco rootlets from naturally infected plant beds and from artificially inoculated tobacco roots growing in sand revealed masses of bacteria, at intervals on the roots, which appeared to be embedded in a matrix, for occasional bacteria which became separated from the surface developed motility while the others showed no movement whatever. Bits of roots bearing these colonies when used as inoculum produced heavy infection of either angular leafspot or wildfire, depending on the source, on water-soaked tobacco leaves.

The causal bacteria of these diseases can maintain themselves on the roots of several unrelated crop plants for at least six months, and can under certain natural conditions cause specific leafspot diseases of several unrelated plants, such as tobacco, tomato, morning-glory and cowpeas. These results seem to give support to the belief that the senior writer has had for many years; namely, that these bacteria are not primarily tobacco pathogens. They appear to be common (but specific) organisms present on roots, perhaps of native vegetation, which can and do, under special favorable circumstances, cause specific leafspots of tobacco.

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[1] The investigation reported in this paper is in connection with a project of the Kentucky Agricultural Experiment Station and is published by permission of the director.

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

APPARATUS FOR THE PRODUCTION OF ARTIFICIAL FROST INJURY IN THE BRANCHES OF LIVING TREES[1]

NATURAL late frost injuries have been used by Glock in the past to determine the presence of multiple growth layers (or "rings") in one year in the branches of living trees. In connection with this work Studhalter suggested that, to serve the same purpose, an apparatus be devised for the production of artificial frost injury under controlled conditions.

The resulting apparatus has certain advantages over other types described by Sorauer[2] and by Mix[3] for application to a portion of a branch. These advantages include ease of application to branches, use of solid carbon dioxide (dry ice), which permits a wide range of low temperature, and the simulation of natural conditions in which the freezing element does not come into direct contact with the plant tissue.

The apparatus, square in cross section, is made of half-inch seasoned lumber and consists of three essential units (Fig. 1), namely, lid, dry-ice chamber and treatment chamber. Sheet cork gives insulation on the interior and aluminum paint on the exterior. Rubber gaskets are placed on all surfaces where the units come in contact.

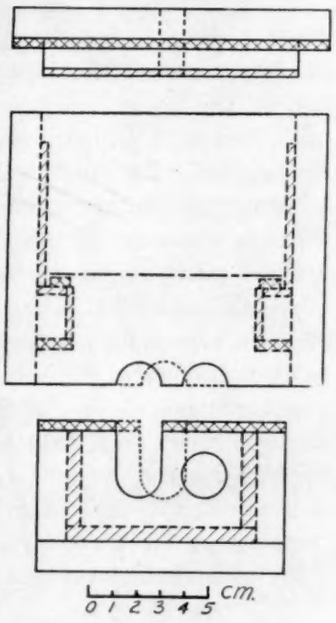

Fig 1. Diagram of apparatus

——— wire shelf
- - - - - - on inner face of apparatus
..... on opposite end of apparatus
//////// cork lining
xxxxxx rubber gasket

FIG. 1

A 1-cm hole through the center of the lid permits the escape of air at the beginning of an experiment and, later, of the carbon dioxide gas as it is pushed upward by the descending colder gas. In the dry-ice chamber a wire screen supports the solid carbon dioxide which is placed in the upper part of the unit. The wire screen rests on a rubber gasket made discontinuous in order to allow free passage of carbon dioxide gas into and out of the lower unit. The treatment chamber fits up into the bottom of the dry-ice chamber. In one side of the treatment chamber a hole receives a low-temperature thermometer held firmly by a cork. Into each of two sides, as shown in the figure, a channel is cut to receive the branch, the one on the same side as the thermometer hole being offset from the middle. Sponge rubber gaskets are cemented into the channels so as to fill them nearly to the top.

An apparatus with the dimensions shown in Fig. 1, which is drawn to scale, will receive branches up to 12 mm in diameter. When the apparatus is applied in the field, the treatment unit is brought up from below to the part of the branch to be frozen so that the branch sinks into the sponge rubber of the channels. Separate blocks of sponge rubber are inserted into the channels on top of the branch. Then the other units are lowered into place and the whole held together by strong rubber bands. If necessary for adequate support, a cord may be passed around the apparatus and over a superjacent limb.

It has been found by experiments during the past two years that the range of temperature obtainable extends from 0 to −45 degrees C. for an interval up to 7 hours. In order to obtain different temperatures, the following factors are varied as the experiments demand: absolute quantity of dry ice, size and number of pieces (to determine the amount of surface exposed), length of time of application and degree of pre-cooling. Extensive calibration studies prove that the dry-ice chamber should be above the treatment chamber for the most effective results.

Throughout two field seasons the apparatus has been used for anatomical and ecological field experiments and for the study of cambial activity especially during and after freezing. It has proved its efficacy in the duplication of natural frost injury and in the placement of an internal label whereby growth flushes are being timed and the number of growth layers determined.

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THE USE OF TERTIARY BUTYL ALCOHOL IN MICROTECHNIQUE

TECHNICIANS, always interested in improving microtechnique by using new reagents, are especially anxious to conserve materials vital to war industry. Tertiary butyl alcohol (TBA) is used partially to replace dehydrating agents such as ethyl alcohol and clearing agents such as xylol and benzol, which are becoming increasingly expensive and difficult to obtain. TBA is obtainable without priority rating,[1] is cheaper than most laboratory reagents,[2] and safe to

[1] Presented at the Dallas, Texas, meetings of the American Association for the Advancement of Science, on December 29, 1941. Abstract in *Amer. Jour. Bot.*, 28 (10, Sup.): 6s, 1941.

[2] P. Sorauer, *Ber. deut. bot. Ges.*, 2: xxii–xxv, 1884.

[3] A. J. Mix, N. Y. (Cornell) *Agr. Exp. Sta. Bul.*, 382: 235–284, 1916.

[1] According to R. W. Greeff and Company, 10 Rockefeller Plaza, New York, N. Y.

[2] Based on list prices of the California Botanical Materials Company, 787 Melville Ave., Palo Alto, Calif.

use if prolonged exposure to a high concentration of vapors is avoided. TBA is miscible with most reagents in common laboratory use.

TBA was first introduced as a dehydrating agent for tissues by Johansen.[3] Although it has been recommended for plant microtechnique,[4,5] little has been written regarding its use for animal tissues.[6] During the past seven years I have found TBA unusually satisfactory for the dehydration of a large variety of normal and pathological mammalian tissues. A comparative study[7] of dehydrating agents showed that it caused less shrinkage of rabbit kidney than dioxan, xylol or chloroform. After TBA dehydration tissue hardening is comparatively slight and cytological details are well preserved.

Although techniques should be varied to suit the size and type of specimen, the following schedules have been found generally satisfactory. For dehydrating tissues a series of solutions of tertiary butyl-ethyl alcohol (TBEA) should be prepared as indicated in Table 1.

TABLE 1

PERCENTAGES OF TBEA SOLUTIONS

Constituents	50 per cent.	70 per cent.	85 per cent.	95 per cent.	100 per cent.
Distilled water	50 cc	30 cc	15 cc	....	....
95 per cent. ethyl alcohol	40 "	50 "	50 "	45 cc	....
Tertiary butyl alcohol ..	10 "	20 "	35 "	55 "	75 cc
Absolute ethyl alcohol ..	....	....	....	....	25 "

Fixed material dehydrated directly from water or through the lower percentages of ethyl alcohol is transferred to 50 per cent. TBEA for 1–2 hours and material washed in alcohol is placed in the corresponding concentration of the TBEA dehydrating mixture. Leave tissues in (1) 70 per cent. TBEA from 2 hours to several days; (2) 85 per cent. TBEA, 1–2 hours; (3) 95 per cent. TBEA, 1–2 hours; (4) 100 per cent. TBEA, 1–3 hours; (5) pure TBA, three changes in 4 hours to overnight; (6) equal parts of pure TBA and paraffin oil, 1–2 hours; and (7) infiltrate with paraffin. This infiltration is accomplished by filling shell vials three-fourths full of melted parowax or paraffin, allowing the paraffin to solidify and then placing the tissue just covered with TBA-paraffin oil mixture on top of the solid paraffin. The vials are then placed in a well-ventilated oven, the temperature of which is several degrees above the melting point of the paraffin. As the paraffin melts the tissue sinks and is gradually infiltrated with paraffin. Starting at least one hour after the tissue has sunk to the bottom of the vial, the melted paraffin should be changed at hourly intervals, at least until the odor of TBA is no longer detectable, usually 2–6 hours. The used paraffin is discarded. If a special paraffin is used for embedding, it should be used as the last change of melted paraffin in the oven. When necessary, very small pieces of tissue which are in 70 per cent. TBEA one morning may be dehydrated during the day, infiltrated with paraffin overnight and sectioned by noon the next day.

The two most important stages in the technique are the final dehydration with TBA and the infiltration with paraffin. It is essential that the free water be removed completely from the tissue before paraffin infiltration and that the TBA and paraffin oil have diffused from the tissues before they are embedded. Although it is better to discard all solutions after using once, if necessary the same solutions may be used several times.

When celloidin or paraffin-celloidin (double embedding) techniques are being used, after dehydration in 100 per cent. TBEA, tissues may be treated according to the usual schedules with ether-alcohol and infiltrated with celloidin or nitrocellulose. Johansen[4] has suggested the use of equal parts of tertiary butyl, ethyl alcohol and ether instead of the usual alcohol-ether as a solvent for celloidin or nitrocellulose.

Since many stains are less soluble in TBA than in ethyl alcohol, TBA is used in dehydrating stained sections, especially when one is anxious to reduce the extraction of ethyl alcohol soluble stains from the tissues.[8] Slides are mounted with balsam, damar or clarite directly from TBA or preferably after passage through xylol or toluol. Celloidin and nitrocellulose are only slightly soluble in TBA, and stained celloidin sections can be dehydrated directly through TBA or TBA with chloroform into xylol before mounting.

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[6] R. E. Stowell, *J. Techn. Methods*, 22 (in press).

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